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Characterizing Three-Dimensional Mixing Process in a River Confluence using Hydro-acoustical Backscatter and Flow Measurement

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River confluences are zones where two rivers with different geomorphic and hydraulic characteristics amalgamate, resulting in rapid change in terms of flow regime, sediment entrainment and hydraulic geometry. In these confluence zones, the flow structure is basically complicated responded with concurrent mixing of physical and chemical aquatic properties, and continuous channel morphology could be changed due to erosion and sedimentation. In addition, the confluences are regions in which two rivers join and play an important role in river ecology. In order to characterize the mixing process of confluence for understanding the impacts of a river on the other river, therefore, it has been crucial to analyze the spatial mixing patterns for main streams depending on various inflow conditions of tributaries. However, most conventional studies have mostly relied upon hydraulic or water quality numerical models for understanding mixing pattern analysis of confluences, due to the difficulties to acquire a wide spatial range of in-situ data especially for characterizing this kind of mixing process. Even with intensive in-situ measurements, those researches tended to focus mainly on the hydraulic characteristics such as the flow and morphological complexity of confluence, so that very few studies comprehensively included sediment variation with flow at the same time. In this study, subsequently, flow and sediment mixing characteristics were concurrently investigated in the confluence between Nakdong and Nam river in South Korea, where it has been frequently questioned to determine how Nam river affects Nakdong river that recently have suffered various environmental problems such as green algae bloom and erosion/deposition in the confluence. We basically examined the mixing characteristics of confluence by using acoustic Doppler current profilers (ADCPs) which were used to measure hydraulic factors such as flow rate and depth, as well as measuring the suspended sediment concentration by using acoustic backscatter. Cross-sectional ADCP measurements in a confluence were collected with high spatial resolution in order to analyze the details of spatial distribution in the perspective of the three-dimensional mixing patterns of flow and sediment, where backscatters (or SNR) measured from ADCPs were used to track sediment mixing assuming that it could be a surrogate to estimate the suspended sediment concentration. Raw backscatter data were corrected by considering the beam spreading and absorption by water. Also, an optical Laser diffraction instrument (LISST) was used to verify the method of acoustic backscatter and to collect the particle size distribution of main stream and tributary. In addition, image-based spatial distributions of sediment mixture in the confluence were monitored in various flow conditions by using an unmanned aerial vehicle (UAV), which were compared with the spatial distribution of acoustic backscatter. As results, we found that when acoustic backscatter and flow measurements by ADCPs were well processed, they could be proper indicators to identify the spatial patterns of the three-dimensional mixing process between two rivers.